Operation and Maintenance Manual for

WP2.1C/WP3.9C Marine Diesel

WEICHAI POWER YANGZHOU DIESEL ENGINE CO., LTD.

Contents

Section I Main Specifications and Engine Data

1.1 Specifications of the Engines

Model		WP2.1C27E1	WP2.1C35E1
Type		Water-cooled, vertical, in-line, four-stroke	
Apiration		Natural aspiration	
No of cylinder - Bore×Stroke mm		4-85×92	
Total displacement L		2.09	
Compression ratio		18 ： 1	
Mean effective pressure kPa		574.6	553.4
Mean piston speed m/s		6.13	8.28
Rated output kW		20	26
Rated Speed r/min		2000	2700
Fuel consumption at rated power[g/kW h）]		≤245	
Oil consumption %		≤0.5	
Speed droop %		≤5	
Low idle speed r/min		800～850	
Firing order		1-3-4-2	
Lubricating method		Combination of pressure and splash	
Cooling method		Pressurized water-cooling	
Starting method		Electric	
Dry weight kg		375	
Overall dimensions	L(mm)	1084	
	W(mm)	718	
	H(mm)	890	

Model		WP3.9C53E1	WP3.9C61E1
Type		Water-cooled, vertical, in-line, four-stroke	
Apiration		Natural aspiration	
No of cylinder - Bore×Stroke mm		4-102×118	
Total displacement L		3.86	
Compression ratio		17.5 ： 1	
Mean effective pressure kPa		590.7	590.7
Mean piston speed m/s		7.87	7.87
Rated output kW		38	38
Rated Speed r/min		2000	2000
Fuel consumption at rated power[g/kW h）]		≤235	
Oil consumption %		≤0.5	
Speed droop %		≤5	
Low idle speed r/min		750～800	
Firing order		1-3-4-2	
Lubricating method		Combination of pressure and splash	
Cooling method		Pressurized water-cooling	
Starting method		Electric	
Dry weight kg		440	
Overall dimensions	L(mm)	1084	
	W(mm)	718	
	H(mm)	890	

*Dimension to flywheel housing end

1.2 Specifications of Main Components

Model		WP2.1C27E201	WP2.1C35E201
Injection pump	Type	In-line, plunger type	
	Designation	4Q366	BH4Q75R8
	Governor	TQA Mechanical centrifugal type	
	Fuel supply pump	Single acting piston pump	
Injector	Type	KBAL-P028	
	Designation	CDSLA 153 P 777	
	Nozzle diameter	5×¢0.22	
Nozzle opening pressure（MPa）		20～20.5	
Lub.oil pump	Type	Rotor	
	Rated speed（r/min）	1900	
	Flow rate（L/min）	15	
Cooling water pump	Type	centrifugation	
	Rated speed（r/min）	1800	
	Flow rate（L/min）	45	
Fuel filter	Type	Spin-on, paper cartridge	
	Designation	CX0708	
Air filter	Type	paper cartridge	
	Designation	K2007	
Lub.oil filter	Type	Spin-on, Full flow	
	Designation	JX0708	
Thermostat	Type	Wax element type	
	Designation	155B	
Starting motor	Designation	QD138Y	
	Voltage（V）	12	
	Power supply（kW）	2.5	
Generator	Designation	JFWZ13	
	Voltage（V）	14	
	Poweroutput（W）	350	

Model		WP3.9C53E1	WP3.9C61E1
Injection pump	Type	In-line, plunger type	
Injector	Type	KBAL-P028	
	Designation	P-Type, Porous type	
Nozzle opening pressure（MPa）		24～25	
Fuel filter	Type	Spin-on, paper cartridge	
	Designation	CX0710T	
Lub.oil filter	Type	Spin-on, Full flow	
	Designation	JX0814ZC	
Lub.oil pump	Type	Gear type	
	Rated speed（r/min）	1900	
	Flow rate（L/min）	15	
Cooling water pump	Type	centrifugation	
	Rated speed（r/min）	3000	
	Flow rate（L/min）	200	
	Voltage（V）	12	
	Power supply（kW）	3.8	
Generator	Designation	JFWZ13	
	Voltage（V）	14	
	Poweroutput（W）	350	
Glow pulug	Designation	2DRS-10-24-105A	10-12-105
	Voltage（V）	24	12
	continuous working period(s)	＜30	＜30
Thermostat	Type	Wax element type	
	Designation	JWQ-1039-76K	
Lub.oil cooler	Type	Disk stack type	
	Designation	28Z2	

1.3 Main Engine Data

Model		WP2.1C27E1	WP2.1C35E1
Lub.oil pressure	rated conditions（KPa）	200-400	
	low idle speed (kPa)	≥50	
	Lub.oil temperature（℃）	≤95	
	Cooling water temperature	75～95	
	Exhaust temperature（℃）	≤480	
Tightening torque specifications：（N.m）	Cylinder head bolts	95～105	
	Main bearing cover bolts	120～135	
	Connecting rod bolts	60～70	
	Flywheel bolts	60～70	
	Crankshaft pulley clamping	140～160	
Valve timing(crankshaft angle, degrees)	Intake valves open(Before)	14	
	Intake valves close(After)	42	
	Exhaust valves open(Before)	42	
	Exhaust valves close(After)	14	
Valve clearances (on cold)（mm）	Intake valves（mm）	0.20～0.25	
	Exhaust valves（mm）	0.25～0.30	
Fuel delivery advance angle		13±1	16±1

Section Ⅱ Operation of the Engine

2.1 Fuel, Lubricating Oil and Cooling Water

Fuel The fuel for the engines is the light diesel oil (grades10, 0, -10, -20 and -35) specified in the China National Standard GB 252. The fuel for different working conditions should be chosen according to the fuel specifications below:

Fuel Specifications

Grade of fuel	10	0	-10	-20	-35
Cetane value	50	50	50	48	43
Pour point(℃)	10	0	-10	-20	-35
Lowest ambient temperature(℃)	+18	+8	-2	-12	-23

Before using, diesel oil should be stored for at least 48 hours to settle down impurities and then filtered with a silk cloth.

Lub.oil : The lubricating oil for the engine should be chosen from the products specified in the China National Standard GB11122 according to ambient temperatures. Proper grades of lubricating oil for different ambient temperatures are shown in the table below.

Lub.oil Specifications

CF grade	10W	5W/30	10W/30	15W/30	15W/40	20W/40	20W/20	30	40
Ambient	-20-5	-25-25	-20-20	-10-25	-10-35	-10-30	-10-10	5-30	＞25

Check the oil level with the dipstick at least 5 mins after refilling or stopping the engine.

Coolant : Coolant for diesel engines should be clean soft water, such as water from rain, snow or clean rivers. In case of hard water, such as water from wells and fountains,

it should be softened beforehand. There are two methods of doing it.

(1) To boil up the hard water.

(2) To add caustic soda into hard water (20 grams of caustic soda for 30 liters of hard water).

2.2 Running-in of the Engine

A new engine or an overhauled one should not be run under rated conditions before it has gone through 50 hours of running –in under part load. Only 2 hours of running-in of the new engines is carried out on the test bench. They should be run about 20 hours under half or lighter load before normal service at rated conditions. Operating an engine under heavy load without going through the running-in period may cause excessive wear, resulting in a reduction of service life or even damages to the cylinder, piston and bearings.

After the replacement of any of the important parts such as the piston, piston ring, cylinder liner, crankshaft, main bearing and connecting rod bearing, the engine should be run at low speed and under light load for 10 to 15 hours before normal service.

If anything abnormal occurs during the running-in period, stop the engine to check for the cause and make corrections.

After running-in proceed to the following operations:

Drain off the oil in the oil pan immediately after stopping the engine. Clean oil pan and strainer with diesel oil.

Replace the oil filter cartridge.

Check and adjust valve clearance.

Check and retighten all the external securing bolts and nuts.

Check and eliminate any abnormality.

Lubricating maintenance.

2.3 Preparations for Starting

2.3.1 Check the tightness and security of the mounting of engine parts and accessories, including the injection pump, fuel filter, lubricating oil filter, generator, electric starter, water pump, fan, pulleys, etc. Check the freedom of movement of the fuel injection pump control levers.

2.3.2 Fill the engine with clean fuel oil, lubricating oil and cooling water as specified

in Section 2.2. Check the oil level in the oil sump. Oil level in the oil sump should be near to the upper mark on the dipstick but not above it.

2.3.3 Check for the leakage of oil and water.

2.3.4 Turn the crankshaft for several revolutions to check whether the movable parts move smoothly without interference.

2.3.5 Check the battery and wiring in the electric system.

2.3.6 Bleed the fuel supply system in the following procedure:

(1) Slacken the venting screw on the fuel filter. Actuate the handle of the prime pump to bleed the fuel filter and pipes. And then retighten the venting screw.

(2) Slacken the venting screw on the injection pump. Bleed the fuel injection pump by actuating the handle of prime pump until no air bubbles can be found in the outflowing fuel. Retighten the venting screw.

(3) Slacken the union nuts connecting the injectors and high pressure fuel pipes. Turn the speed control lever of the governor to its halfway position. Crank the engine by means of the starting motor until fuel flows out from the joints. Then retighten the union nuts.

2.4 Starting the Engine

Before starting check to see that the prime pump handle resists hand operation and that a puffing sound of injector can be heard when engine is cranked. If not, bleed the fuel system again.

Turn the speed control lever halfway and set the starting switch to the “start” position to start the engine. In cold weather, open the drain cock on the cylinder block and refill the cooling system with hot water until drain water temperature is over 30℃. Then start the engine in the procedure described above.

It is not allowed to run the starting motor continuously for more than ten seconds. If the engine fails to start up, wait for two minutes before making another attempt. It is necessary to check over the engine if it fails to start up for three times in succession. After starting up, let the engine run at about 800 r/min for several minutes. Do not load the engine until the lubricating oil pressure is in the normal range. Running at rated speed and full load is not allowed until the outlet cooling water temperature reaches 60 ℃. During operation, pay close attention to the indications of meters especially that for lubricating oil pressure.

Before stopping the engine, reduce the load and speed gradually. Stop the engine by pulling the engine stop lever after the engine has been run at idle speed for several minutes. In case of engine running away choke the intake pipe to stop the engine.

If the ambient temperature falls below 0℃ and the engine is not to be run for a long time, drain the cooling water from the engine and radiator to prevent frost

fracture of the engine.

Section Ⅲ Engine Assembly and Disassembly

3.1 Cylinder Head

The monolithic cylinder head is made of high strength cast iron. The fuel injectors and valve train parts are mounted on the cylinder head.

The cylinder head assembly is composed mainly of cylinder head, fuel injectors, valve mechanism, intake and exhaust manifolds, front cover plate, rear cover plate, thermostat and water temperature sensor.

The inlet and exhaust valve guides are of the same design. The valve guide and valve seat insert are press-fitted into the cylinder head. The valves are not interchangeable because they and their seats have been lapped in pairs to form continuous, regular and bright seating lines. No leakage is allowed in the seat line of the valve. The normal valve seating line width is 1.0～1.4mm. If it gets too wide to ensure tight sealing, reshape it by means of a special reamer. Each valve is marked with a cylinder number, because they are not interchangeable in assembly. The standard valve recession, i.e. the specified distance from the valve head to the cylinder head surface is 0.4±0.1mm (see Fig.1). If the valve recession is too small, ream the valve insert to enlarge it; if it is too large, replace the valve and valve seat.

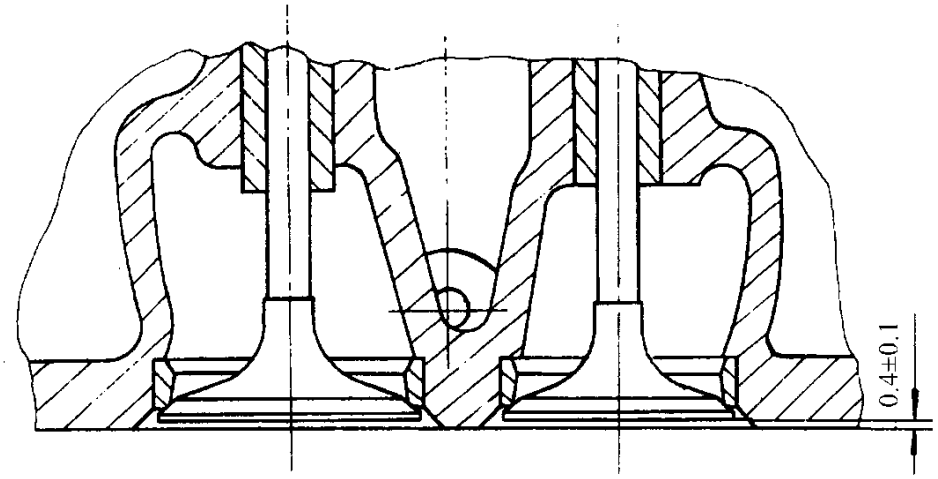


Fig.1

The cylinder head is mounted on the cylinder block with 18 bolts. They should be evenly tightened in 2～3 steps . The tightening of the bolts in each step should

be done in the order as shown in Fig.2. When dismounting the cylinder head, slacken the bolts in the reverse order. The operation procedure should be followed to prevent leakage and cylinder head deformation.

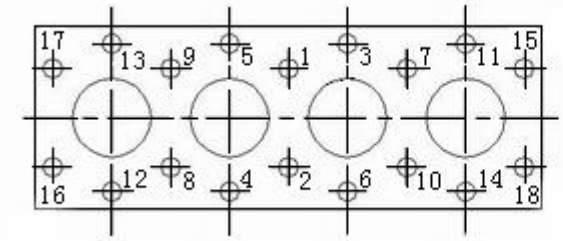


Fig.2

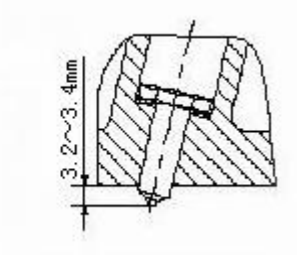


Fig.3

When mounting the fuel injector into the cylinder head, make sure that the protrusion of the injector tip from the cylinder head reaches the specified value (see Fig.3). It can be adjusted with shims.

3.2 Cylinder Block

On the front, there are the gear case, gear case cover, oil pump, timing gears, water pump and fan assembly.

On the left side of the cylinder block mounted the injection pump, lubricating oil filter and oil cooler.There is an inspection window on gear case for timing the injection pump in service. Before dismounting the injection pump, remove the inspection window covers and turn the crankshaft (less than two revolutions) so as to align the mark on injection pump gear with the points in the inspection windows respectively (you can make a mark on the injection pump gear also). The crankshaft should not be turned before mounting the injection pump again. When mounting, make sure that the mark on the injection pump gear is aligned with the point in the inspection window.

On the right side are mounted the generator, starting motor.

The flywheel housing is attached to the rear of the cylinder block. Through the inspection window on the top of the flywheel housing, marks can be seen on the rim of the flywheel indicating the TDC and the beginning of fuel delivery to the first cylinder. Both flywheel and flywheel housing have the SAE standard dimensions.

The main bearing covers and the cylinder block are machined in couple. The main bearing covers are marked with sequence numbers and orientational arrow marks. They are not interchangeable and should be installed with the arrow marks pointing to the front side (fan and gear side) of the engine. When tightening the main

bearing cover bolts, tighten the middle ones first and then the ones on both sides symmetrically to complete one operation step. The specified torque should be reached gradually in 2～3 steps.

The two halves of main bearings are different. The upper one has an oil groove and an oil hole. It should be placed in the bearing saddle of the cylinder block. On both sides of the fifth main bearing cover are installed two thrust bearings to control the endwise movement of the crankshaft. The thrust bearings should be placed with the grooved face outward.The cylinder liner is of the dry type. After the liners are pressed into the cylinder block, the top surface of each cylinder liner collar should be 0.04～0.12 mm higher above the surface of the cylinder block (see Fig.4). For the same cylinder block, the difference in the height between one cylinder liner and another should be less than 0.05 mm. If this dimensional tolerance is exceeded, replace the wrong cylinder liners with selected ones. When pressing-in a liner, be sure to apply the force evenly and perpendicularly on its top.

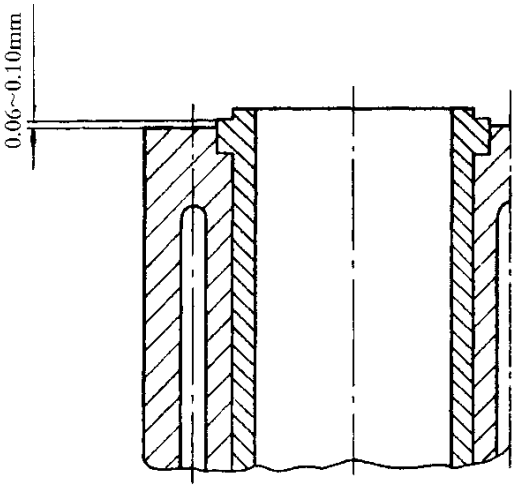


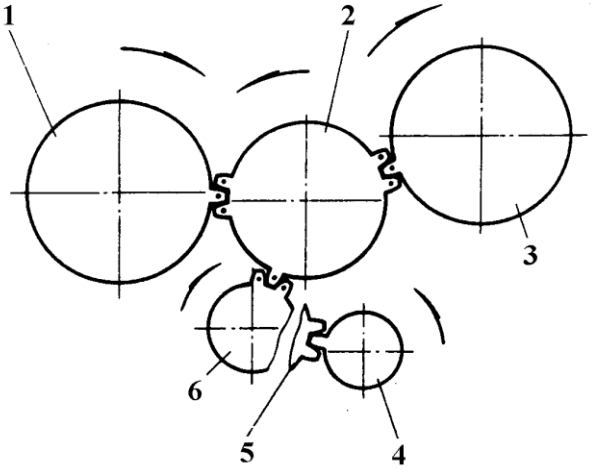
Fig. 4

There is a graphite-coated gasket between the cylinder block and cylinder head. Check to see that the holes in the gasket line up respectively with the holes for the locating sleeves and the holes for the circulation of water and oil in the cylinder block. Place an O-ring seal (6.3×18) in the oil hole of the gasket.

3.3 Valve System

Both camshaft gear (part 1 in Fig.4) and injection pump gear (part 3 in Fig. 4) are driven by the crankshaft gear (part 6 in Fig.4) via an idle gear (part 2 in Fig. 4). These gears have dot marks on them . In assembly, all the marks should be correctly placed to ensure correct valve timing and injection timing (see Fig.5) .

The valves are opened and closed in certain timing events. They are driven by the camshaft through tappets, push rods and rocker arms.



1. Camshaft timing gear 2. Idle gear 3. Injection pump gear
4. Oil pump gear 5. Oil pump driving gear 6.Crankshaft timing

Fig. 5

The valves are opened and closed in certain timing events. They are driven by the camshaft through tappets, push rods and rocker arms.

3.4 Crank-connecting Rod Mechanism

The crank-connecting rod mechanism is composed of the piston-connecting rod assembly and crankshaft-flywheel assembly.

The piston-connecting rod assembly consists of the piston, compression rings, oil scraper ring, piston pin, connecting rod, connecting rod bearings and connecting rod bolts.

The crankshaft-flywheel assembly consists of the crankshaft, flywheel, crankshaft timing gear and crankshaft pulley.

Two compression rings and one oil scraper ring are fitted into the piston. The first compression ring is a keystone type ring. When the rings are fitted into their grooves, their gaps should be apart from each other around the circumference of the piston. Furthermore the oil scraper ring should be so placed that its gap is 90 degrees apart from the pinhole centre around the circumference. The second compression ring should have its top surface (marked with STD in the area near the gap) upward in assembly. When checking the ring gap, place the ring into a cylinder liner and measure it with a feeler gauge.

If the gap is too small, correct it by fine filing; if too large, replace the ring with a new one.

When assembling the piston and connecting rod, heat the piston in hot oil to the temperature of 100 to 120 degrees centigrade and then push the piston pin through them.

The connecting rod and cap are machined and marked in couples. They are not interchangeable. Two connecting rod bolts should be tightened step by step in turn to reach the specified torque.

Before placing the piston and connecting rod assembly into the liner smear them with a little clean oil. Make sure the intake valve pocket (the larger one of the two pockets on the piston) is on the left side of the exhaust valve pocket viewed from the injection pump side of the engine in assembly. When moving the piston and connecting rod through the cylinder liner, be careful not to bruise the liner surface.

The difference in weight between the piston-connecting assemblies for the same engine should be less than 10 grammes. This requirement can be met through selection.

The crankshaft is made of ductile nodular cast iron. There are five main journals and four crankpins on the crankshaft. An oil hole in each journal leading to the neighboring crankpin is employed to supply lubricating oil to the crankpin bearing. On the front end of the crankshaft, there are the timing gear and oil pump driving gear, both driven with a flat key. On the front and rear of the crankshaft, there are oil seals to prevent oil leakage. When installing the flywheel, tighten the flywheel bolts evenly in the order shown in Fig.6 to reach the specified torque in 2～3 steps. The crankshaft and flywheel are dynamically balanced as an assembly. The same figure is marked side by side on the crankshaft flange end and the flywheel as an indication of the pairing relation and mounting position. Be sure to assemble the flywheel with the crankshaft in the correct position as indicated with the figure mark.

3.5 Fuel Supply System

The fuel supply system consists of the fuel tank, rough filter, feed pump, fine filter, injection pump, governor, injectors and fuel pipelines.Fuel from the fuel tank flows through the strainer into the feed pump and then pass through the fuel filter to the injection pump. The fuel at high pressure from the injection pump is delivered to the fuel injector and sprayed into the combustion chamber. The superfluous fuel from the injection pump and injectors flows back to the fuel tank.（see Fig.7）。

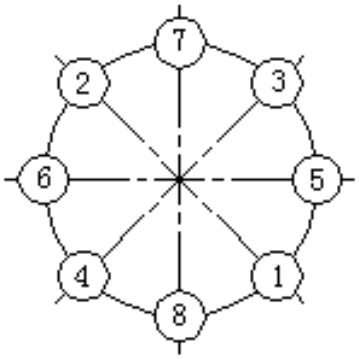


Fig. 6

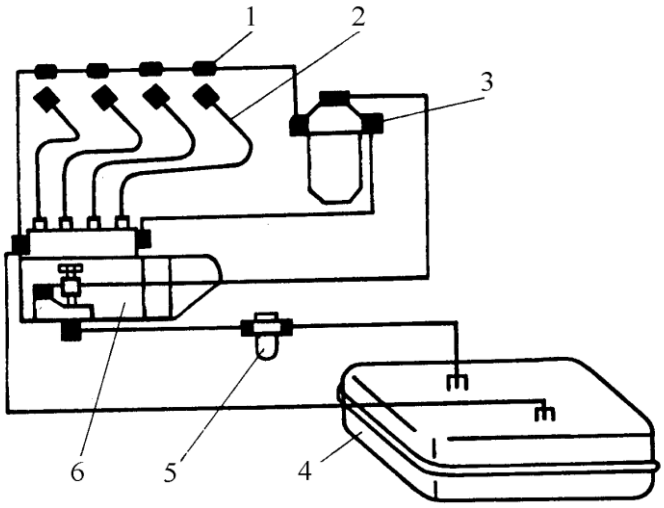


Fig. 7

1. Fuel return pipe　2. Fuel injection pipe　3. Fuel fine
4. Fuel tank　5. fuel rough filter　6. Filter

The fuel feed pump is of single-acting and plunger type. It is mounted on one side of the injection pump and driven by a cam on the camshaft of the pump. A primer pump is attached on the feed pump to bleed air from the fuel pipeline before starting the engine. When it is not in use, lock the primer pump handle by pressing and turning the nut on the top of it to prevent leakage of fuel.

Fuel should be kept absolutely clean to ensure a long service life of the parts in the fuel supply system. Replace the cartridge with a new one if it is clogged.

The fuel injection pump is the BQ or PL series injection pumps. The injection pump has been adjusted and sealed in the factory. It should not be readjusted by customers except when absolutely necessary. All the service operations should be carried out by qualified servicemen on an injection pump tester according to the instructions in the service manual of the injection pump.

The TQA type governor is a centrifugal and variable-speed governor. The maximum speed setting screw is used to set the maximum speed of the engine and the idle speed setting screw is for low idle setting. The speed setting screws have been properly adjusted in the factory and are not allowed to be readjusted by customers.

The P type injector has a nozzle with 5 holes of dia.0.22mm. It is mounted with one clamping plate and one tightening bolt. The injector nozzle tip protrusion is 3.3±0.1mm.

Special shims are used for adjusting the protrusion. The nozzle needle and valve seat are finely matched to each other and should not be interchanged. Keep the injector parts absolutely clean during maintenance operation.

3.6 Lubricating System

The lubricating system consists of the oil pump, oil pump strainer, oil filter and oil pipeline.

The lubrication of the engine is of the splash-and-pressure combined type. Some bearings such as the main bearing, connecting rod bearing, camshaft bearing and rocker arm bearing are pressure-lubricated, while other friction surface such as the cylinder liner, piston, piston pin, valves and gears are lubricated by splashed oil.

The lubricating oil drawn by the oil pump flows into the oil filter. Filtered oil flows through the main oil gallery in the cylinder block to lubricate the crankshaft main bearings, camshaft bushings and rocker arm bushings, and oil through the oil hole from the crankshaft journal to the crank pin to lubricate the connecting rod bearing.

The lubricating oil filter cartridge is a spin-on canister. In case the cartridge is seriously clogged, the bypass valve will open, allowing unfiltered oil to flow directly to the main oil gallery in the cylinder block. Be sure to follow the instructions described in Chapter V during maintenance operation of the oil filter. Replace the filter cartridge if necessary. The pressure adjusting valve serves to adjust the oil pressure in the main oil gallery and keep it within the range from 200kPa to 500kPa.

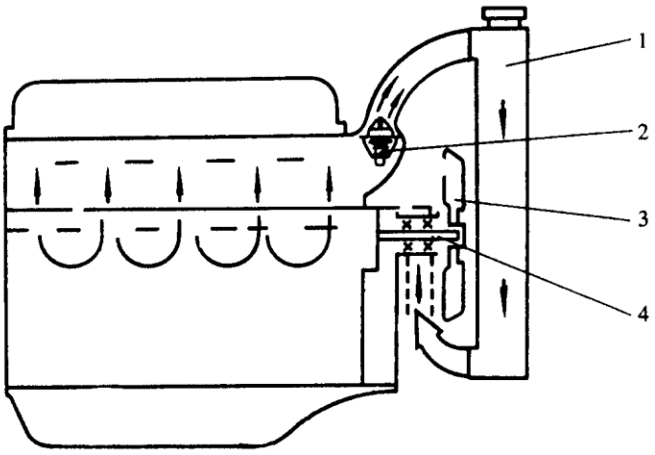
3.7 Cooling System

The engine has a pressure type cooling system. It consists of the radiator, fan, water pump and thermostat.

When the engine cooling water temperature is below 73℃, the thermostat is closed and

the cooling water is stopped from going to the radiator. It goes from the thermostat housing back to the water pump. So the engine will be warmed up in a short while. As the water temperature gets higher above 80℃ ,the thermostat opens gradually and lets the cooling water into the radiator. The cooling water from the radiator goes through the tube and back into the water pump.

The water pump is of the centrifugal type. Its maintenance-free bearings need no greasing. When water continuously leaks out from the weep hole in the bottom of the pump housing due to excessive wear of the water seal, dismount the impeller from the shaft and replace the water seal.（see Fig.8）



1. Radiator 2. Thermostat
3.Fan 4. Water pump

Fig. 8

3.8 Electrical System

The electrical system consists of the starting motor and a generator with a silicon rectifier. Be sure to have the negative pole of the generator connected to the ground.

The electrical system voltage is 12V and the generator power output is 350W.

Power supply of the starting motor is 3.8kW.

Section Ⅳ Adjustment of the Engine

4.1 Adjustment of Valve Clearances

It is essential to adjust the valve clearances in operating an engine. The valve clearances on cold engines are 0.20mm for inlet valves and 0.25mm for exhaust valves. Apart from the adjustment of valve clearances after reassembling the engine, it is necessary to check and adjust the valve clearances periodically because of the possible loosening of adjusting screws and wear of parts in the valve system. The inspection interval is recommended to be 250 running hours.

The adjustment should be carried out on a cold engine. The procedure is as follows: Remove the cylinder head cover. Turn the crankshaft until the mark of the top dead center of the first cylinder on the crankshaft pulley aligns with the pointer of the timing indicator. When the piston of the first cylinder is at its top dead center on the compression stroke, both intake and exhaust valves of the first cylinder are closed. In this position, check the clearances of intake valve and exhaust valve of the first cylinder, the intake valve of the second cylinder and the exhaust valve of the third cylinder (i.e. the clearances of the first, second, third and sixth valves counted from the front) with a feeler gauge.To adjust the valve clearances, slacken the lock nut with a wrench and hold it, screw in or out the adjusting screw with a screwdriver until the feeler gauge inserted between the rocker head and the top surface of the valve stem feels neither too loose nor too tight. Then tighten the lock nut and check the clearance again. Readjust if necessary till it is properly set.

After the adjustment of the clearances of the above-mentioned four valves, rotate the crankshaft a complete turn to place the piston of the forth cylinder at its top dead center on the compression stroke. In this position, check the clearances of intake valve and exhaust valve of the fourth cylinder, the intake valve of the third cylinder and the exhaust valve of the second cylinder (i.e. the clearances of the fourth, fifth, seventh and eighth valves counted from the front). Adjust the clearances of these valves in the same way as described above.

4.2 Adjustment of Fuel Injection Timing

In order to maintain fuel economy and power characteristics of the engine, it is necessary to check and adjust the fuel delivery advance angle after the engine being reassembled or running for 500 hours.

The procedure for checking and adjusting is as follows:

Remove the high-pressure fuel pipe for the first cylinder; join a pipe to a thin glass tube and connect it with the first cylinder delivery valve holder of the injection pump. Set the speed control lever to the maximum delivery position and bleed off the air in the fuel system. (Turn the crankshaft till there are no air bubbles in the fuel flowing out of the glass tube). Then turn the crankshaft slowly and watch attentively for the rise of the fuel level in the glass tube. Stop turning the crankshaft at the beginning of the rise of fuel level which implies the beginning of the fuel delivery to the first cylinder. Check to see if the mark of fuel delivery to the first cylinder on the flywheel aligns with the timing pointer inside the flywheel housing. If it does not, readjust in the following procedure. Slacken the bolts which fasten the injection pump onto the connecting flange. Turning the injection pump with its top towards the cylinder block results in the increase in the fuel delivery advance angle, and vice versa.

4.3 Adjustment of Nozzle Opening Pressure

Dismount the fuel injector from the cylinder head and mount it on the injector tester for checking and adjusting. Actuate the pump handle and watch the indication of pressure. At the time of injection starting, the pressure should be within the range as specified in Section Ⅰ, Main Engine Data. The fuel spray should be uniform and the puffing sound of injection should be short and clear.

The opening pressure of the P-type injector can be adjusted by choosing from different adjusting shims of the thickness in the range from 1.0 mm to 2.0mm. The gauge step is 0.01mm. Most of the injector manufactures use the shims of the thickness from 1.7mm to 1.9mm. Before reassembling the injector, clean the nozzle valve and the adjusting shim. Care must be taken not to scratch the matching faces. After attaining the specified pressure, remount the lock nut and check for the opening pressure again.

4.4 Adjustment of Lubricating Oil Pressure

Pay frequent attention to the lubricating oil pressure. The normal oil pressure ranges from 200 kPa to 500 kPa. The adjustment of lubricating oil pressure should be carried out after the engine gets warm (when the lubricating oil temperature is around 80℃). Dismount the sealing nut from the adjusting screw on the oil filter. Turn the adjusting screw to adjust oil pressure. Screw in or out the adjusting screw to increase or decrease the oil pressure. After adjustment, put on the sealing washer and then tighten the sealing nut.

4.5 Adjustment of injection pump

The injection pump has been adjusted and sealed in the factory. It should not be readjusted by customers except when absolutely necessary. All the service operations should be carried out by qualified servicemen on an injection pump tester according to the instructions in the service manual of the injection pump.

4.6 Adjustment of V-belt Tension

Though very easy to adjust, the tension of V-belt has great influence on the rotational speed of the generator and water pump and hence the operation of the engine.

It is recommended to adjust it periodically. When engine is not running, press on the middle of a straight section of the belt with a force of 30～40 N. The sag of V-belt should be within the range of 10～15 mm. If not qualified, loosen the adjusting bolt on the adjusting bracket to move the generator to adjust the belt to a proper tension. Excessive tension will shorten the service life of the belt and cause the premature wear of bearings in the generator and water pump due to the heavy load resulted from excessive belt tension. Insufficient belt tension, however, will lead to the belt creep and fracture, resulting in the engine overheating.

Section Ⅴ Technical Maintenance

Regular maintenance of the engine is essential to efficient and trouble-free operation, good mileage between major repairs and long service life. General procedures of different assignments of technical maintenance stipulated below should be followed in principle. Customers can make some alterations according to particular service conditions.

The maintenance work schedule is as follows:

1) Shift maintenance

2) Maintenance at the completion of 125 working hours.

3) Maintenance at the completion of 500 working hours.

4) Maintenance at the completion of 1000 working hours.

5.1 Shift Maintenance

A) Check the oil level in oil sump and injection pump. Refill to the specified level if necessary.

B) Check the water level in the radiator. Refill if necessary. C) Check the fuel level in fuel tank. Refill if necessary.

D) Check the tightness of mounting bolts of the engine and installing bolts of components.

Tighten them if necessary.

E) Check the leakages of air, oil and water. Repair if necessary.

F) Eliminate all faults and abnormal conditions found in operation. G) Clean the engine and accessories of oil sludge and dust.

H) Clean the air filter and air duct every day in dusty environment.

5.2 Maintenance at the Completion of Every 125 Working Hours

A) Complete all the procedures mentioned above.

B) Check the tension of the fan belt. Adjust it if necessary.

5.3 Maintenance at the Completion of Every 500 Working Hours

A) Clean away dust from the paper cartridge and dust chamber of the air cleaner.
B) Check the valve clearances and make adjustments if necessary

C) At the completion of every 250 working hours, replace oil filter cartridge.

D) At the completion of every 250 working hours, replace fuel filter cartridge.

E) Complete all the procedures mentioned above.

F) Check the seat lines of valves. Relap valves and readjust valve clearances if necessary.

G) Check the fuel delivery advance angle. Readjust it if necessary.

H) Check the nozzle opening pressure and spray pattern. Readjust the injection pressure.

I) Check the tightening torque of main bearing bolts and connecting rod bolts.

J) Check the leakage from the weep hole of the water pump. Replace the water seal if the leaking rate is too high.

K) Clear the silencer of carbon deposits.

L) Check all cable connections in the electric system. Clean and tighten the connections if dark burned spots are found.

5.4 Maintenance at the Completion of Every 1000 Working Hours

A) Complete all the procedures mentioned above.

B) Replace air filter cartridge.

C) Clear the cooling system of scale.

D) Clean the fuel tank and fuel pipeline.

E) Check for technical conditions and performance of the engine to see if it needs some repairing. Dismount and inspect relevant parts. Clear away carbon deposits from cylinder head, piston, piston rings and cylinder liner. Check to see if the piston rings, cylinder liner, crank pin bearing or main journal bearing are subject to premature wearing.

5.5 Engine Preservation

If the engine is to be kept in store for a long period of time, it should be treated beforehand in the following procedures.

A) Drain lubricating oil, cooling water and fuel oil from the engine when it is hot.

B) Dismount intake and exhaust manifolds. Through the inlet and exhaust ports in the cylinder head, pour 200 grammes dehydrated lubricating oil into each cylinder. Rotate the crankshaft to apply the oil to the piston, piston rings, cylinder liner and valve seats.

C) Cover the openings on the engine to prevent foreign objects and moisture from entering them.

D) Smear rust resisting oil on the unpainted surface of the engine.

E) Store the engine in a clean, dry place with good ventilation. The engine should not be stored near chemicals.

F) Repeat the procedures from A to E for every six months during the engine storage.

Section Ⅵ Trouble-shooting

6.1 Failure to Start

Possible Causes	Suggested Remedies
(1) Fuel tank empty or fuel tank cock not open.	Refill fuel tank. Open cock.

(2) Fuel pipeline or fuel filter clogged.	Dismount fuel pipeline or fuel filter. Clean or replace them.
(3) Air within fuel system.	Bleed fuel system. Tighten all fuel pipe connections.
(4)Defective injection pump or incorrect injection timing.	Check fuel feed pump and injection pump. Adjust injection timing.
(5)No injection or poor characteristics of spray.	Clean and lap nozzle needle and body in pair. Readjust nozzle opening pressure.
(6) Ambient temperature too low and engine too cold.	Heat cooling water.
(7) Insufficient compression pressure in cylinders.	See item 6.3 hereafter.
(8) Starting motor runs at low speed or will not run.	See item 6.12 hereafter.

6.2 Lack of Power

Possible Causes	Suggested Remedies
(1) Insufficient compression pressure in cylinders.	See item 6.3 below.
(2) Wrong grade of fuel or fuel contaminated with water	Use proper fuel. Clean fuel tank and refill.
(3) Clogged air cleaner.	Clean air cleaner cartridge. Replace cartridge if necessary.
(4) Choked exhaust silencer.	Clear away carbon deposits or dirt from silencer.
(5) Air within fuel system.	Bleed fuel system. Tighten all fuel pipeline connections.
(6) Incorrect valve timing.	Inspect camshaft and marks on gears. Check valve clearances.
(7) Incorrect fuel delivery advance angle	Check marks on gears. Readjust fuel delivery advance angle.
(8) Low injection pressure or poor spray characteristics.	Readjust nozzle opening pressure.
(9) Uneven distribution of fuel among cylinders.	Readjust uniformity of fuel delivery from fuel injection pump to cylinders.
(10) Engine unable to reach the rated speed.	Reset speed control lever.

6.3 Insufficient Compression Pressure in Cylinder

Possible Causes	Suggested Remedies
(1) Valve clearance too small or no clearance.	Readjust valve clearance.
(2) Carbon deposits on valve and seat. Worn valve and seat.	Clear away carbon deposits and relap valve and valve seat. Ream valve seat if necessary.

(3) Piston ring worn or lack of tension.	Replace piston ring.
(4) Piston ring stuck due to carbon deposits.	Clean piston and rings in kerosene.
(5) Cylinder liner and piston worn. Clearance between cylinder and piston too big.	Replace liner and piston or rebore liner and use oversize piston.
(6) Leakage in cylinder head gasket face.	Retighten cylinder head bolts or replace the gasket.
(7) Gas leakage in injector mounting bore.	Check copper washer. Reset injector.
(8) Broken valve spring.	Replace valve spring.
(9) Valve stuck in valve guide.	Clean valve in kerosene. Replace if it is worn out or deformed.

6.4 Engine Stalls

Possible Causes	Suggested Remedies
(1) No fuel in tank.	Refill fuel tank.
(2) Air and water in fuel system.	Bleed fuel system. Drain water from fuel tank. Replace cartridge of fuel filter.
(3) Clogged fuel filter.	Clean or replace cartridge.
(4) Choked air cleaner.	Replace air cleaner cartridge.
(5) Piston stuck in cylinder.	Repair or replace piston and cylinder liner.

6.5 Engine Racing

Possible Causes	Suggested Remedies
(1) Faulty governor	Stop the engine. Dismount injection pump and governor. Repair or replace governor.
(2) Restricted injection pump control rod.	Stop the engine. Repair injection pump.
(3) Clip ring disconnected from control rod.	Stop the engine and check. Reinstall clip ring.

6.6 Abnormal Noise

Possible Causes	Suggested Remedies
(1) Engine detonating with clear knocking noise in cylinder.	Readjust injection timing.
(2) Delayed combustion. Backfire in exhaust pipe.	Readjust injection timing.

(3) Clearance between piston and cylinder liner too big, causing thudding noise (The noise disappears after fuel delivery to the cylinder being cut off for 3 to 5 seconds)	Check and repair. Replace piston and liner if necessary.
(4) Clearance between crankshaft and main bearing too big, causing low heavy pounding noise periodically.	Check and repair. Replace main bearing or thrust plate.
(5) Clearance between crankpin and bearing too big, causing dull pounding noise.	Check and repair. Replace connecting rod bearing.
(6) Clearance between piston pin and connecting rod bushing too big, causing sharp knocking noise.	Check and repair. Replace bushing.
(7) Valve clearance too big, causing chattering noise.	Readjust valve clearance.
(8) Piston striking valve, causing clear metal noise.	Readjust valve clearance and valve timing.

6.7 Black Exhaust

Possible Causes	Suggested Remedies
(1) Engine overloaded.	Reduce load.
(2) Fuel delivery not even or too much.	Adjust injection pump and governor.
(3) Injection pressure too low, causing poor spray characteristics.	Readjust nozzle opening pressure.
(4) Fuel injection timing too late.	Readjust injection timing.
(5) Air cleaner choked.	Clear away dust from cartridge or replace cartridge.
(6) Wrong grade of fuel or bad fuel.	Drain tank and refill with proper fuel.

6.8 Coolant Temperature Too High

Possible Causes	Suggested Remedies
(1) Cooling water flow reduction due to loose V-belt.	Adjust belt tension or replace V-belt.
(2) Engine overloaded for a long period.	Reduce load.
(3) Cooling water insufficient.	Refill radiator.

(4) Cooling water flow reduction due to low water pump efficiency.	Check clearance between water pump impeller and housing. Replace impeller if necessary.
(5) Defective water pump impeller.	Replace impeller.
(6) Cooling water circulation obstructed.	Clean cooling system.
(7) Defective thermostat.	Replace thermostat.
(8) Defective water thermometer.	Replace thermometer.
(9) Insufficient lubrication.	Inspect lubricating system and clean oil gallery.

6.9 Low Lubricating Oil Pressure

Possible Causes	Suggested Remedies
(1) Insufficient oil in oil sump.	Check oil level. Refill to the specified level.
(2) Defective low oil pressure alarm.	Replace alarm.
(3) Clogged oil gallery.	Clean oil gallery and blow away dirt with compressed air.
(4) Clogged oil strainer.	Dismount oil strainer. Clean it in kerosene.
(5) Clogged oil filter and defective by-pass valve.	Replace oil filter cartridge. Readjust by-pass valve if necessary.
(6) Excessive bearing clearances due to wear of main bearing and crankpin bearing.	Repair or replace bearings.
(7) Engine overheated, causing high temperature and low viscosity of lubricating oil.	Reduce load to lower oil temperature or refill with suitable oil.
(8) Too big clearance between oil pump rotors and housing cover.	Replace rotors or housing cover of oil pump.

6.10 Excessive Oil Consumption

Possible Causes	Suggested Remedies
(1) Worn piston ring or oil scraper ring stuck in ring groove due to carbon deposits.	Wash oil scraper ring in kerosene or replace defective ring.
(2) Oil return holes plugged due to carbon deposits.	Clean oil return holes in piston.
(3) Oil level too high. Oil into the combustion chamber.	Check with dipstick and drain oil to correct level.
(4) Leakage in lubricating system.	Tighten connectors and replace sealing washers and gaskets.

6.11 Deterioration of Lubricating Oil

Possible Causes	Suggested Remedies
(1) Piston ring worn or stuck in groove, causing combustion gas or fuel to leak into the oil sump.	Clean or replace piston ring.
(2) Water leaking into oil due to faulty cylinder gasket.	Replace gasket.
(3) Water leaking into oil due to crack in cylinder head.	Replace cylinder head.

6.12 Trouble Shooting in Electrical System

Symptoms and causes	Suggested Remedies
A)Faulty generator, no recharging of battery or current too weak.	
1)Loose connections on generator and battery or corroded contacts.	Check and tighten all connections. Clean contacting surfaces and improve insulation.
2)V-belt slip.	Readjust belt tension.
3)Generator out of order.	Check and repair.
B)Current too strong and generator overheated.	
1)Short-circuit between armature and field coil.	Repair or replace.
2)Faulty voltage regulator.	Repair or replace.
C)Resistor of regulator burnt out	
1)Battery terminals incorrectly connected.	Reconnect cables.
2)Cutout relay out of order, current reversed at low engine speed.	Repair or replace.
D) Starting motor will not run.	
1)Loose connection of cables.	Clean off dirt. Tighten connections.
2)Battery not fully charged.	Check and recharge it.
3)Bad contact of brushes.	Clean and polish with fine sandpaper.
4)Short-circuit within starting motor.	Check and repair.
E)Starting motor will run idle but unable to crank the engine up.	
Symptoms and Causes	Suggested Remedies
1)Bad contact of brush.	Clean and polish with fine sandpaper.
2)Bad contact of cable connection and switch.	Clean off dirt. Tighten all connections.
3)Weak battery.	Check and recharge it.

Appendix I Spare parts of Diesel Engine WP2.1/2.5CD

No.	Part Name	No.	Part Name
1	Valve spring, outer	11	First compression ring
2	Valve spring, inner	12	Second compression ring
3	Intake valve	13	Oil scraper ring assembly
4	Exhaust valve	14	Connecting rod bearing
5	Valve collet	15	Front oil seal
6	Cylinder liner	16	Rear oil seal
7	Cylinder head gasket	17	V-belt
8	Upper main bearing	18	Oil filter cartridge
9	Lower main bearing	19	Fuel filter cartridge
10	Piston	20	Nozzle needle-body pair